1,097,233

PATENT SPECIFICATION

DRAWINGS ATTACHED

1,097,233

Date of filing Complete Specification: February 23, 1966.

Application Date: December 1, 1964. No. 48830/64

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Int. Cl.:—B 23 k 19/00.

COMPLETE SPECIFICATION

Improvements in Friction Welding Machines

PATENTS ACT, 1949

SPECIFICATION NO. 1,097,233

Reference has been directed, in pursuance of Section 9, subsection (1) of the Patents Act, 1949, to Patent No. 1,063,229.

THE PATENT OFFICE,
15th October 1968

D 109363/7

stationary component being allowed to rub against the rotating component under an axial force to create heat, and when sufficient heat has been generated by this rubbing, the rotating component is stopped abruptly (or the stationary component released) and the axial force is increased between the two components to create the final weld.

An object of this present invention is to improve upon the normal machine layout, and to provide layouts whereby one pair of components can be loaded whilst another pair of components is being welded, or alternatively to weld together two pairs of components simultaneously.

According to one aspect of the invention, we provide a friction welding machine having a first set and a second set of workpiece holding means each set comprising a driven rotatable workpiece holder facing a further workpiece holder capable of holding a workpiece against rotation, the four holders being at least substantially coaxial, one holder of each set being axially stationary and the other holders both being mounted on common movable support means, the machine also including means for moving the support means for

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consist of a non-rotatable clamp or gripping device, and an end-stop for axially supporting a workpiece held by the clamp or gripping device.

One preferred arrangement consists in a friction welding machine having two stationary heads each provided with a rotatable workpiece holder and driving means therefor, the holders being coaxial and facing each other, a shuttle frame carried by the heads and consisting of two or more rods parallel to the axis of the said holders and a cross head carried between the heads by the rods, the rods being longitudinally slidable on the heads and the cross head carrying two fixed workpiece holders arranged back to back and facing respective rotatable holders, and a plurality of fluid-pressure operated cylinders on the heads containing pistons attached to the rods for moving the frame.

Another preferred arrangement consists in a friction welding machine having a stationary head provided with two rotatable workpiece holders and driving means therefor, the holders being coaxial and facing in opposite directions, a shuttle frame carried by the head and consisting of at least two rods parallel to the axis of

SPECIFICATION AMENDED - SEE ATTACHED SLIP

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COMPLETE SPECIFICATION

Improvements in Friction Welding Machines

We, GEORGE ALEXANDER BLACK and EDWARD HERBERT HANDS, both of 44 Masons Hill, Bromley, Kent, and both of British Nationality, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement :—

In friction welding machines generally welding of two components is carried out by holding one component in a rotating chuck or fixture, and the other component in a stationary chuck or fixture, the stationary component being allowed to rub against the rotating component under an axial force to create heat, and when sufficient heat has been generated by this rubbing, the rotating component is stopped abruptly (or the stationary component released) and the axial force is increased between the two components to create the final weld.

An object of this present invention is to improve upon the normal machine layout, and to provide layouts whereby one pair of components can be loaded whilst another pair of components is being welded, or alternatively to weld together two pairs of components simultaneously.

According to one aspect of the invention, we provide a friction welding machine having a first set and a second set of workpiece holding means each set comprising a driven rotatable workpiece holder facing a further workpiece holder capable of holding a workpiece against rotation, the four holders being at least substantially coaxial, one holder of each set being axially stationary and the other holders both being mounted on common movable support means, the machine also including means for moving the support means for bringing into contact workpieces held by the holders of one or both sets. Two fixtures or chucks for holding the two stationary components may be arranged back to back between the rotatable holders.

Alternatively the rotatable holders may be back to back between the further holders.

Of the said other holders, one may be slidable on the support means, the means for moving the support means acting between the support means and the slidable holder.

One or each of the further holders may consist of a non-rotatable clamp or gripping device, and an end-stop for axially supporting a workpiece held by the clamp or gripping device.

One preferred arrangement consists in a friction welding machine having two stationary heads each provided with a rotatable workpiece holder and driving means therefor, the holders being coaxial and facing each other, a shuttle frame carried by the heads and consisting of two or more rods parallel to the axis of the said holders and a cross head carried between the heads by the rods, the rods being longitudinally slidable on the heads and the cross head carrying two fixed workpiece holders arranged back to back and facing respective rotatable holders, and a plurality of fluid-pressure operated cylinders on the heads containing pistons attached to the rods for moving the frame.

Another preferred arrangement consists in a friction welding machine having a stationary head provided with two rotatable workpiece holders and driving means therefor, the holders being coaxial and facing in opposite directions, a shuttle frame carried by the head and consisting of at least two rods parallel to the axis of

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the said holders and at each end of the rods a cross head joining the rods, the rods being longitudinally slidable on the head and each cross head carrying a fixed workpiece holder coaxial with and facing a respective one of the rotatable holders, and a plurality of fluid-pressure operated cylinders on the heads, traversed by the rods and containing pistons attached to the rods for moving the frame.

Another preferred arrangement consists in a friction welding machine having a stationary head provided with two rotatable workpiece holders and driving means therefor, the holders being coaxial and facing in opposite directions, a shuttle frame carried by the head and consisting of at least two rods parallel to the axis of the holders, at each end of the rods a cross head joining the rods, the rods being slidable on the head, and a further cross head slidable on the rods between the stationary head and one of the cross heads, further workpiece holders on the other of the cross heads and the further cross head, the further holders being coaxial with and facing respective ones of the rotatable holders and being adapted to hold workpieces against rotation, and at least one fluid-pressure operated cylinder acting between the further cross head and the said one of the cross heads for urging the further holders towards the rotatable holders.

According to another aspect of the invention, we provide a friction welding machine having a stationary head with driven rotatable workpiece holding means adapted to hold a single workpiece projecting simultaneously in opposite directions from the said holding means, and support means axially slidable on the head and carrying two further workpiece holders each arranged to face a respective end of a single workpiece held by the said holding means and capable of holding a further workpiece against rotation and of axially supporting said further workpiece while allowing it to rotate.

The invention will be further described with reference to the accompanying diagrammatic drawings, in which:

Figure 1 illustrates a first embodiment of the invention;

Figure 2 illustrates a second embodiment of the invention;

Figure 3 illustrates a third embodiment of the invention;

Figure 4 illustrates a fourth embodiment of the invention;

Figures 5 and 5*a* illustrate a fifth embodiment of the invention;

In the friction welding machine illustrated by Figure 1, a single loading platform 1 is provided, having two non-rotatable chucks or clamps 2, 3, arranged back to back on each of two opposite sides of the platform. Guide rods 4 parallel to the axes of the chucks or clamps project on each of the said sides of the platform. Facing the stationary chucks or clamps are respective machine heads 5, 6 each carrying a rotatable chuck or clamp 7, 8 aligned with the stationary chucks or clamps, each with driving means (not shown) for rotating the rotatable chuck or clamp. The heads also carry guides 9 in which run the guide rods, and hydraulic or pneumatic cylinders 10 enveloping the ends of the rods, which form or carry pistons 11. The heads are fixed and by admitting fluid to or exhausting it from the cylinders the shuttle framework constituted by the guide rods and the platform carried thereby can be moved to and fro between the machine heads. Thus a workpiece can be welded with the aid of e.g. head 5 and the facing stationary chuck or clamp 2, the other head 6 and its associated stationary chuck or clamp 3 being meanwhile held apart so that workpieces can be loaded. On completion of the welded and loading operations, the guide rods and platform are slid towards the other machine head 6 so that the newly loaded workpieces can be welded while the newly welded workpieces can be unloaded and replaced by fresh workpieces. Thus welding is carried out at the two heads in alternation so that the time hitherto wasted in loading and unloading can be materially reduced. The loading platform consists of a cross head 14 and two cross heads 15 carrying the chucks or clamps. Cross-head 14 carries end stops 16 which axially engage and support workpieces held in chucks or clamps 2, 3. As shown in Figure 1, fixtures 2, 3 are fluid-operated clamps whereas fixtures 7, 8 are chucks.

In Figure 2 the positions of the machine heads and loading platform are interchanged, that is to say, the two heads 5, 6 are arranged back to back between two loading platforms 1, 1*a* each carrying one inwardly facing stationary workpiece holder 2, 3 and linked by parallel rods 4 sliding on the machine heads and forming the shuttle framework. The rods pass through fluid-pressure cylinders 10 on the heads and carry pistons 11 within the cylinders. Operation is as already described welding and loading taking place in alternation at each head as the shuttle framework is slid to and fro.

In Figure 3 the machine heads 5, 6 are again back to back between two loading platforms 1, 1*a*, the platform consists of a cross head 15*a* carrying chuck or clamp 3 and slidable on the guide rods 4 under the thrust of a fluid-pressure cylinder 12

acting between the said platform and a cross head 14*a* of the shuttle framework; the cylinders on the machine head are omitted. In this case thrust exerted on the platform 1*a* pushes it towards the opposing machine head 6 while the reaction of the thrust acts on the shuttle framework to draw the other platform 1 towards the other machine head 5. Thus a single fluid-pressure cylinder and a single drive motor for rotatable clamps 7, 8 can be used for welding two pairs of workpieces simultaneously, and heads 5, 6 can be regarded as a single head.

In Figure 4, also for simultaneous welding, the two machine heads 5, 6 face in the same direction and each is opposite a loading platform 1, 1*a*, the two platforms being carried by a shuttle framework on the heads as outlined above and the several workpiece holders 2, 3, 7, 8 of the heads and platforms being coaxial. One or more hydraulic or pneumatic cylinders 10 provide axial relative motion of the machine heads and shuttle framework.

It is not essential that the machine heads be fixed; thus in arrangements similar to Figures 1, 2, and 4 the platforms could be fixed and the heads slidable, and in an arrangement similar to Figure 3 one of the platforms could be fixed and the other platform and the other heads slidable.

In Figures 3 and 4 a single motor may drive both machine heads, but in Figures 1 and 2 a separate motor or at least a separate power transmission mechanism is needed for each head.

Each of the described arrangements leads to economies in that production can be substantially increased by the use of two (or more) pairs of workpiece holders while it is still only necessary to provide one hydraulic or pneumatic system to exert the necessary large welding pressure.

In Figure 5 the two heads are replaced by a single head 13 incorporating a driven hollow rotatable spindle with chucks 7, 8 at each end, so that a workpiece can be held by and project from both chucks simultaneously. The rest of the machine is similar to that of Figure 3 with the exception that the chucks or clamps 2, 3 of the loading platforms must be capable of providing axial support while allowing free rotation of a workpiece held thereby. For example, fixture 3 is shown as a chuck, being provided with a thrust bearing in cross head 15*a* and with means for locking it against rotation, whereas fixture 2 is shown as a fluid-operated clamp, which is non-rotatable, associated with an end stop 16 which is rotatable and is provided with a thrust bearing in cross head 14. Alternatively, as shown in Figure 5*a*, fixture 2 could be a chuck with a thrust bearing and locking means in cross head 15, with a fixed end stop 16.

The machine illustrated in Figure 5 can be used like that of Figure 3 for simultaneous welding of two pairs of workpieces. In addition, it can be used to weld components to opposite ends of a long rod or tube fixed in and projecting in opposite directions from chucks 7, 8. The two components to be welded to the rod or tube are held in fixtures 2, 3. Welding is performed in two steps. First, clamp 2 grips its component and chuck 3 is free to rotate, so that when cylinder 12 is pressurized the component held in chuck 3 rotates with the rod or tube while that held in clamp 2 is welded. Then, clamp 2 is released and chuck 3 is locked against rotation, so that the component held in chuck 3 is welded while the previously welded component rotates with the rod or tube, being axially supported by end stop 16 and its thrust bearing. The alternative arrangement illustrated by Figure 5*a* is used similarly. The sequence of the steps could be reversed.

It will be clear that the machine of Figure 5 is derived from that of Figure 3 by giving the two chucks 7, 8 of the latter a common drive and an axial space extending through and between them to accommodate a single workpiece.

WHAT WE CLAIM IS:—

1. A friction welding machine having a first set and a second set of workpiece holding means each set comprising a driven rotatable workpiece holder facing a further workpiece holder capable of holding a workpiece against rotation, the four holders being at least substantially coaxial, one holder of each set being axially stationary and the other holders both being mounted on common movable support means, the machine also including means for moving the support means for bringing into contact workpieces held by the holders of one or both sets.

2. A friction welding machine as claimed in claim 1 in which corresponding holders of each set are placed back to back between the remaining holders.

3. A friction welding machine as claimed in claim 2 in which the means for moving the support means acts between the support means and one or more fixed points.

4. A friction welding machine as claimed in claim 2 in which of the holders mounted on the support means one is fast with the support means and the other is axially slidable on the support means, and the means for moving the support means acts between the support means and the last-mentioned holder.

5. A friction welding machine as claimed in claim 2, 3, or 4, in which the

holders placed back to back are the rotatable holders and are axially fixed.

6. A friction welding machine as claimed in claim 2, 3, or 4 in which the holders placed back to back are the said further holders and are mounted on the support means.

7. A friction welding machine as claimed in any of claims 1 to 6 in which each of the further holders consists of a non-rotatable clamp and an associated end stop for axially supporting a workpiece held by the clamp.

8. A friction welding machine as claimed in claim 4 in which the said corresponding holders are the driven rotatable holders and an axial space extends through and between these holders whereby a single workpiece can be held in and project from both holders simultaneously, and in which each of the further holders is capable of holding a workpiece against rotation and of axially supporting a workpiece while allowing the workpiece to rotate the driven holders having common driving means.

9. A friction welding machine having a stationary head with driven rotatable workpiece holding means adapted to hold a single workpiece projecting simultaneously in opposite directions from the said holding means, and support means axially slidable on the head and carrying two further workpiece holders each arranged to face a respective end of a single workpiece held by the said holding means and capable of holding a further workpiece against rotation and of axially supporting said further workpiece while allowing it to rotate.

10. A friction welding machine having a stationary head incorporating a hollow driven rotatable spindle with a workpiece holder at each end whereby a single workpiece can be held in both holders simultaneously, and support means axially slidable on the head and carrying two further workpiece holders each facing a respective end of the spindle and capable of holding a workpiece against rotation and of axially supporting a workpiece while allowing the workpiece to rotate.

11. A friction welding machine as claimed in claim 8, 9, or 10 in which at least one of the further holders includes a workpiece gripping device which can be fixed against or freed for rotation which device is associated with a thrust bearing.

12. A friction welding machine as claimed in claim 8, 9, 10, or 11 in which at least one of the further holders includes a non-rotatable workpiece gripping device and a rotatable end support associated with a thrust bearing.

13. A friction welding machine as claimed in any of claims 1 to 12 in which the support means is a shuttle framework consisting of at least two rods parallel to the axis of the holders and at least one cross head interconnecting the rod, the rods being coplanar with each other and the axis.

14. A friction welding machine as claimed in any of claims 1 to 13 in which the means for axially moving the support means consists of one or more fluid-pressure operated cylinders.

15. A friction welding machine as claimed in claim 3, or any of claims 5, 6, and 7 as appended to claim 3, in which the means for axially moving the support means consists of a plurality of fluid-pressure operated cylinders and the support means is a shuttle frame which can slide on a fixed head carrying the said one holder of each set on opposite sides of the head, the said cylinders being mounted on the head and being traversed by piston rods constituting part of the frame.

16. A friction welding machine as claimed in claim 4 or any of claims 5, 7, 13, and 14 as appended to claim 4, in which the holders placed back to back are the rotatable holders and a common drive is provided for the rotatable holders.

17. A friction welding machine having two stationary heads each provided with a rotatable workpiece holder and driving means therefor, the holders being coaxial and facing each other, a shuttle frame carried by the heads and consisting of two or more rods parallel to the axis of the said holders and a cross head carried between the head by the rods, the rods being longitudinally slidable on the heads and the cross head carrying two fixed workpiece holders arranged back to back and facing respective rotatable holders, and a plurality of fluid-pressure operated cylinders on the heads containing pistons attached to the rods for moving the frame.

18. A friction welding machine having a stationary head provided with two rotatable workpiece holders and driving means therefor, the holders being coaxial and facing in opposite directions, a shuttle frame carried by the head and consisting of at least two rods, parallel to the axis of the said holders and at each end of the rods a cross head joining the rods, the rods being longitudinally slidable on the head and each cross head carrying a fixed workpiece holder coaxial with and facing a respective one of the rotatable holders, and a plurality of fluid-pressure operated cylinders on the heads, traversed by the rods and containing pistons attached to the rods for moving the frame.

19. A friction welding machine having a stationary head provided with two

rotatable workpiece holders and driving means therefor, the holders being coaxial and facing in opposite directions, a shuttle frame carried by the head and consisting of at least two rods parallel to the axis of the holders, at each end of the rods a cross head joining the rods, the rods being slidable on the head and a further cross head slidable on the rods between the stationary head and one of the cross heads, further workpiece holders on the other of the cross heads and the further cross head, the further holders being coaxial with and facing respective ones of the rotatable holders and being adapted to hold workpieces against rotation, and at least one fluid-pressure operated cylinder acting between the further cross head and the said one of the cross heads for urging the further holders towards the rotatable holders.

20. A friction welding machine as claimed in claim 19 in which at least one of the further holders includes a workpiece gripping device which can be fixed against or freed for rotation which device is associated with a thrust bearing.

21. A friction welding machine as claimed in claim 19 or 20 in which at least one of the further holders includes a non-rotatable workpiece gripping device and a rotatable end support associated with a thrust bearing.

22. A friction welding machine substantially as herein described with reference to Figure 1 of the accompanying drawings.

23. A friction welding machine substantially as herein described with reference to Figure 2 of the accompanying drawings.

24. A friction welding machine substantially as herein described with reference to Figure 3 of the accompanying drawings.

25. A friction welding machine substantially as herein described with reference to Figure 4 of the accompanying drawings.

26. A friction welding machine substantially as herein described with reference to Figure 5 or 5*a* of the accompanying drawings.

MARKS & CLERK,
Chartered Patent Agents,
Agents for the Applicants.

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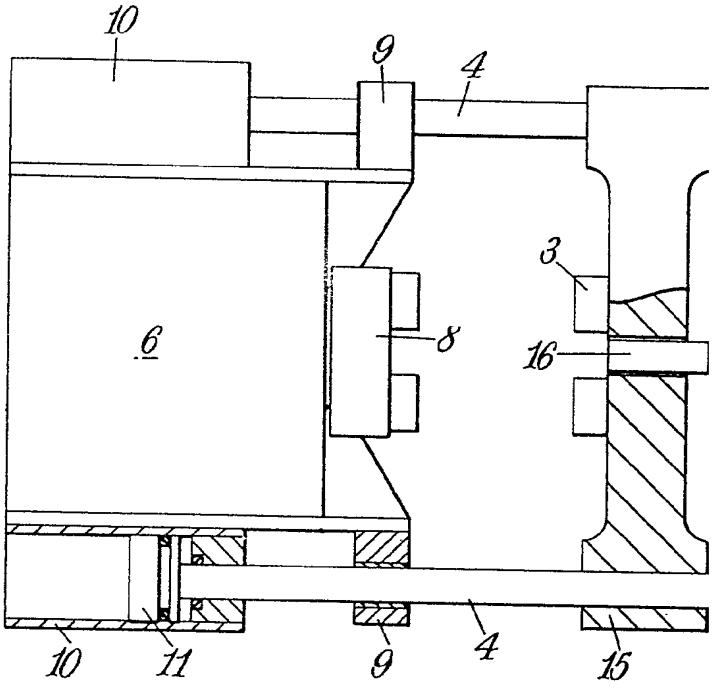
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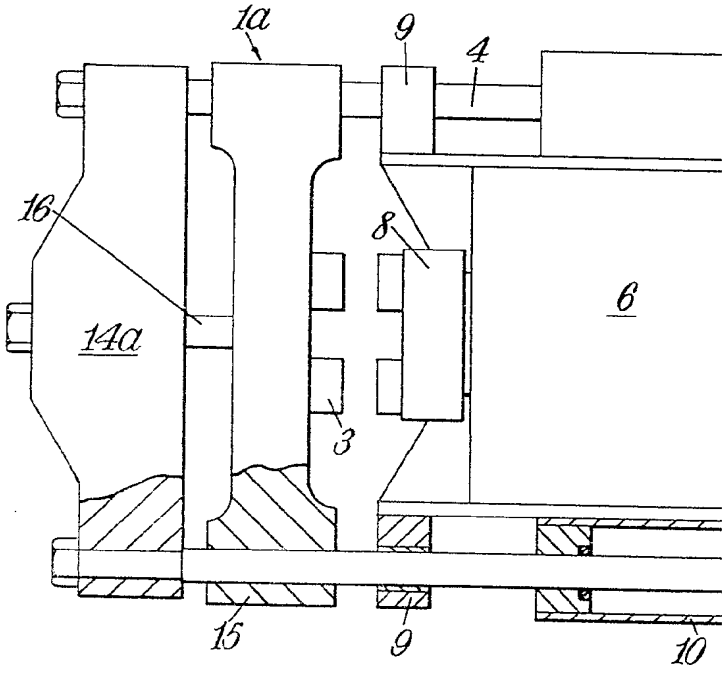
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COMPLETE SPECIFICATION

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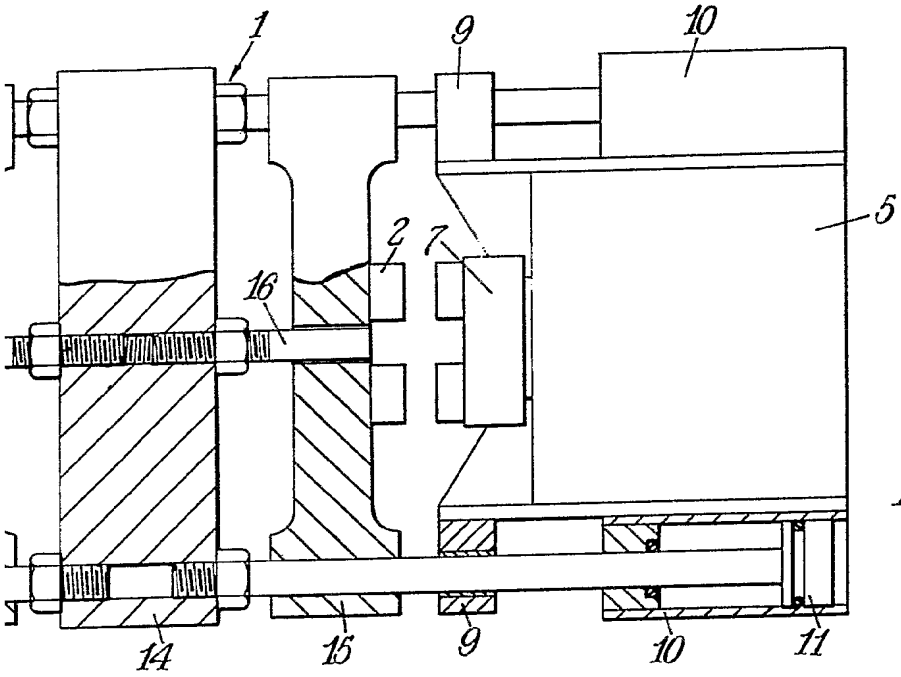

Fig. 1

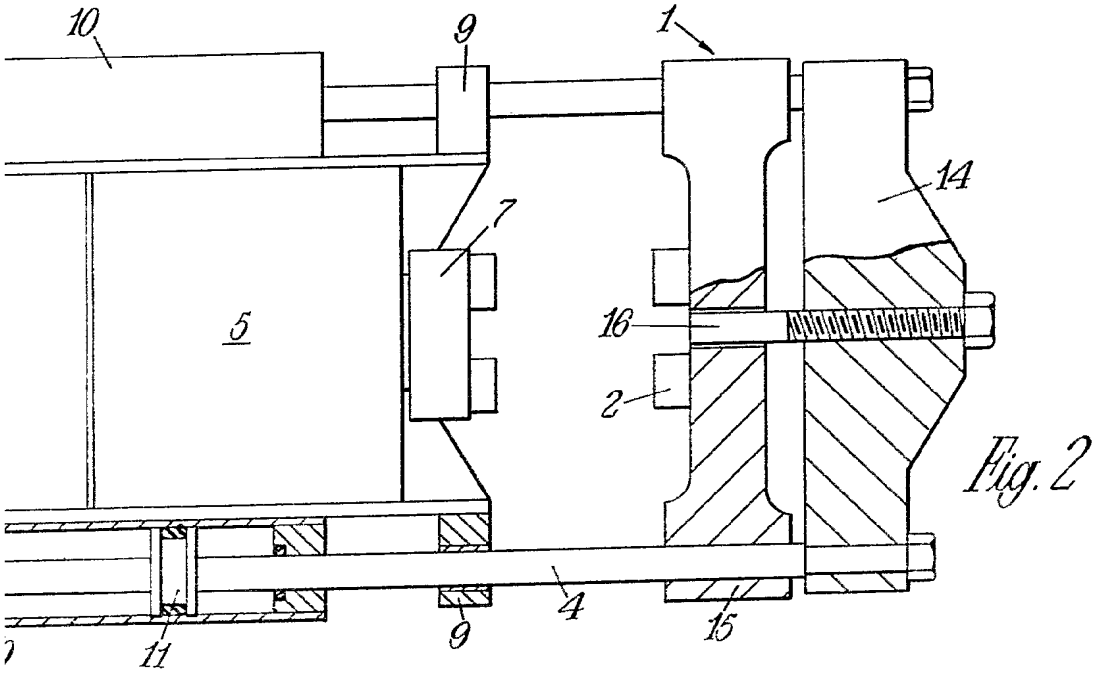

Fig. 2

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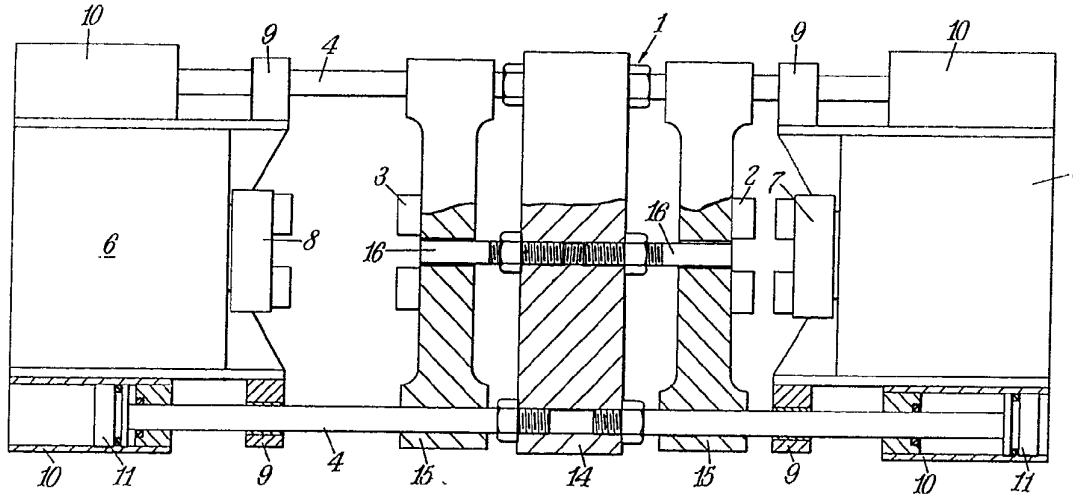


Fig. 1

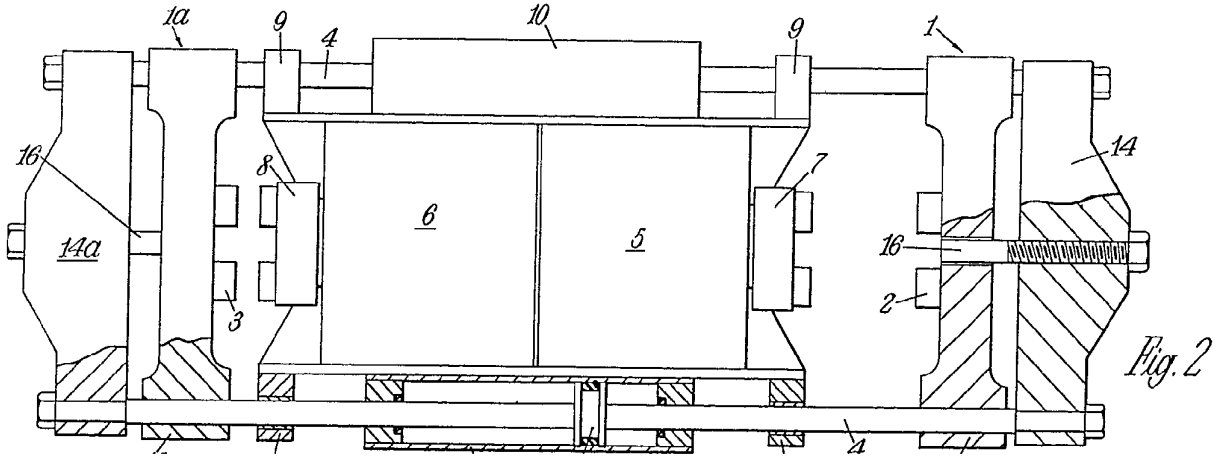
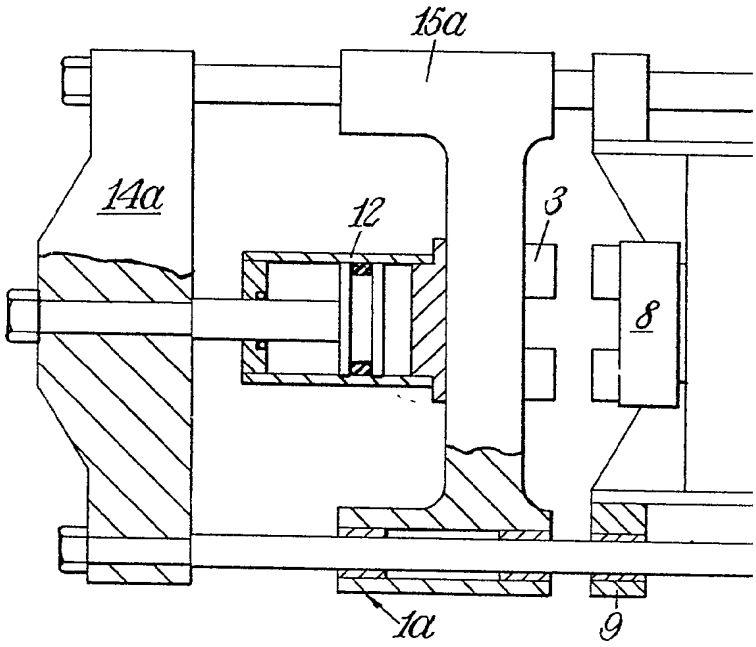


Fig. 2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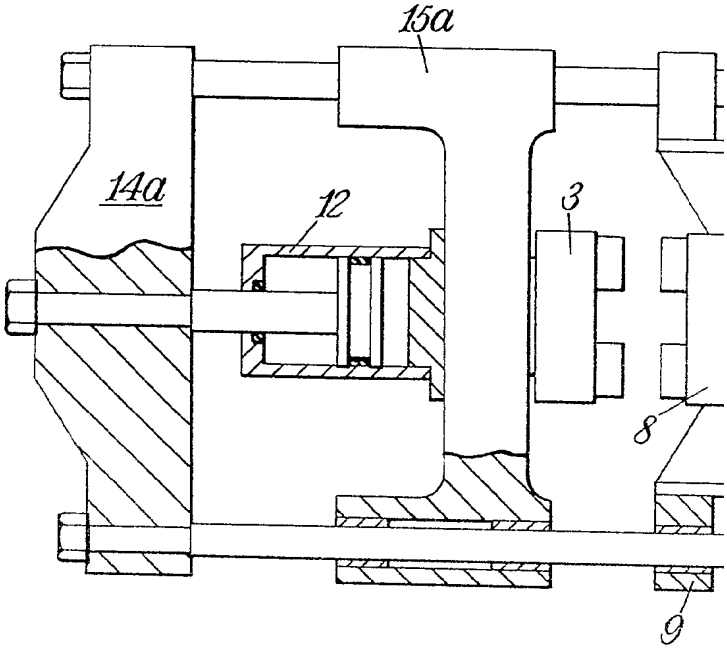
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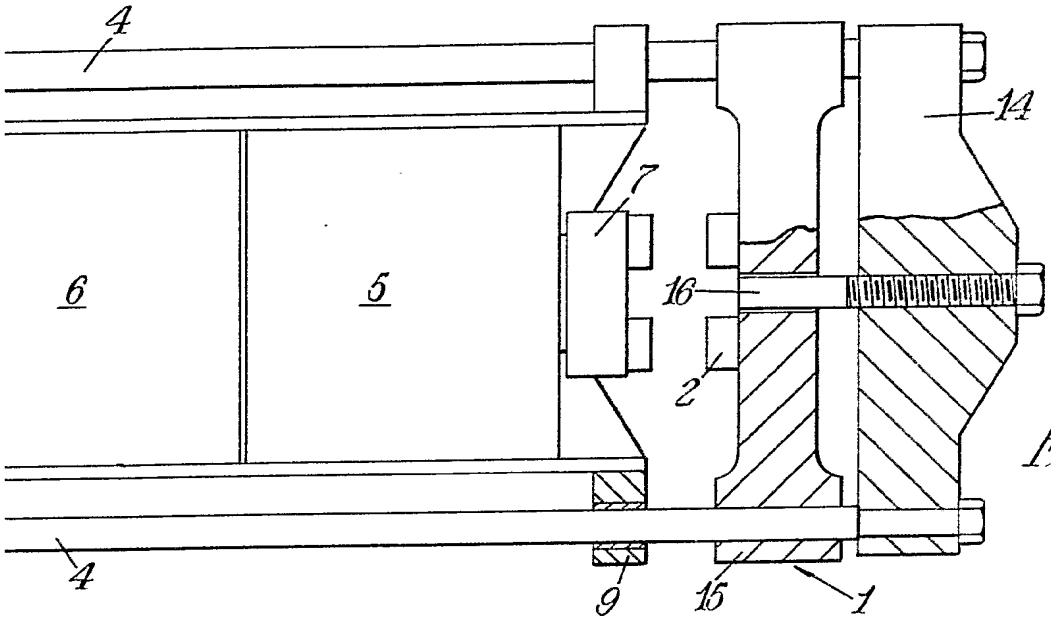

Fig. 3

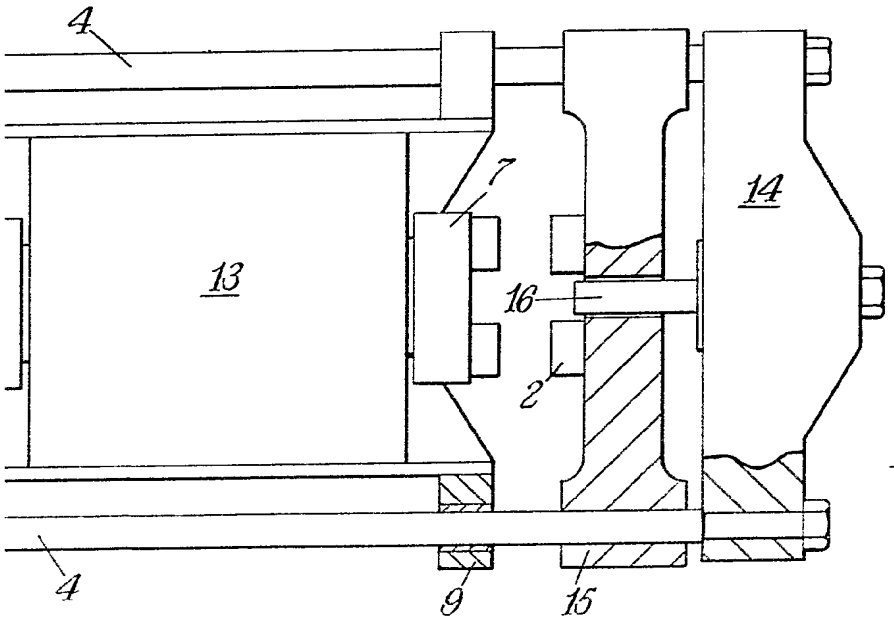

Fig. 5

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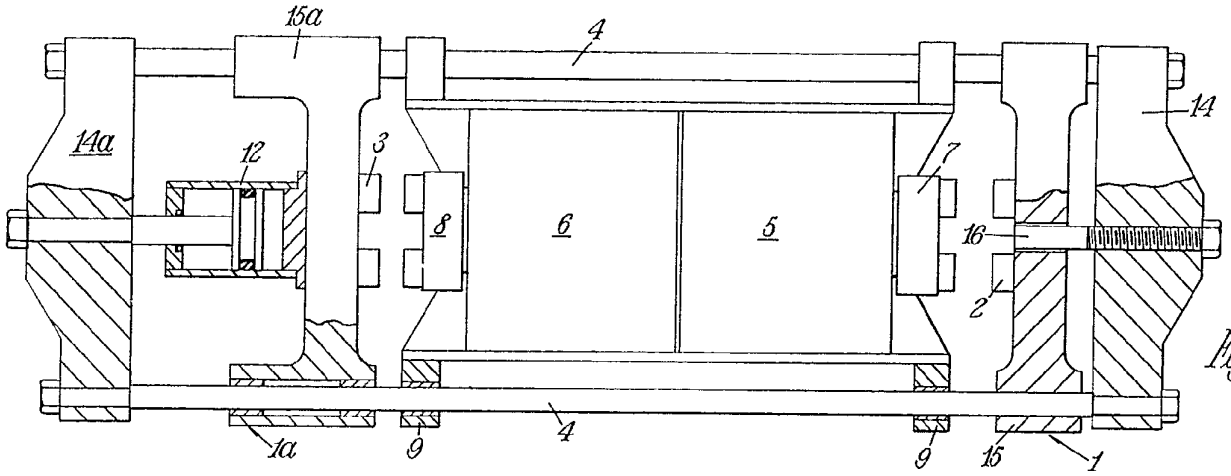

Fig. 3

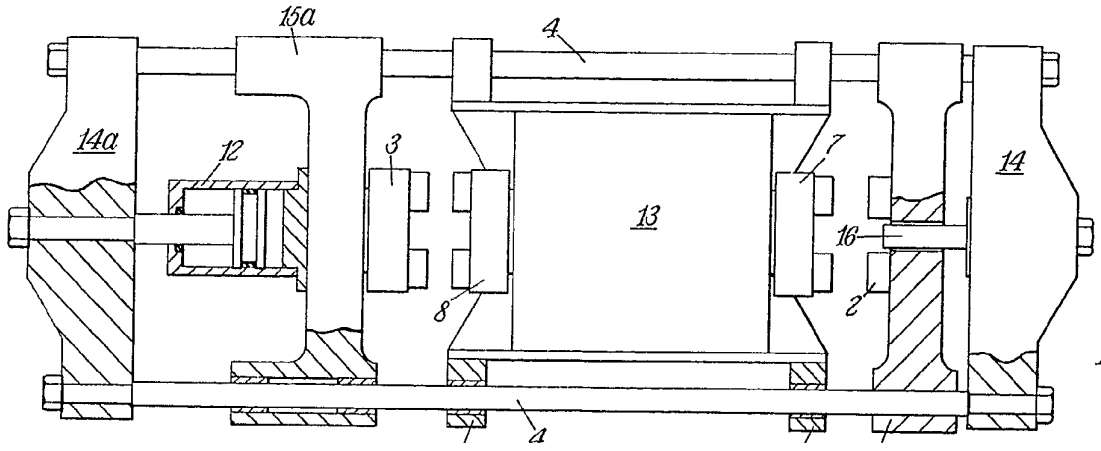

Fig. 5

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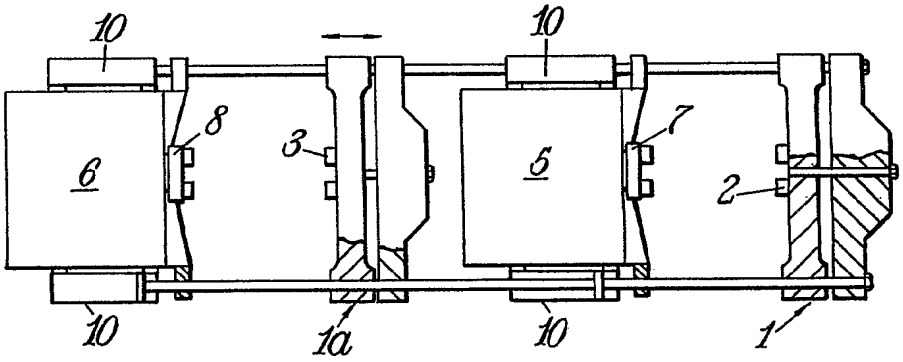

Fig. 4

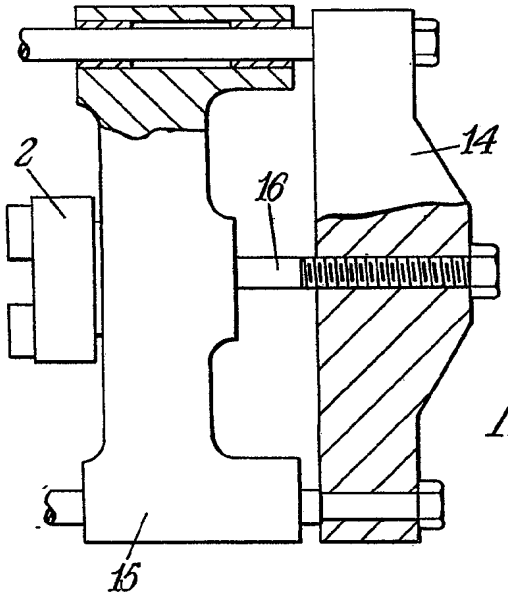

Fig. 5a